


# DRAFT

## Mattole Watershed Synthesis Report



*The mission of the North Coast Watershed Assessment Program is to conserve and improve California's north coast anadromous salmonid populations by conducting, in cooperation with public and private landowners, systematic multi-scale assessments of watershed conditions to determine factors affecting salmonid production and recommend measures for watershed improvements.*

# Appendices

## Glossary

**AGGRADATION:** The geologic process by which stream beds, floodplains, and the bottoms of other water bodies are raised in elevation by the deposition of material eroded and transported from other areas. It is the opposite of degradation.

**ALEVIN:** The life stage of salmonids that occurs after eggs have hatched but before young emerge from the gravel nests where they have incubated. Alevin still have yolk sacs attached to provide them with nutrition within the nest.

**ALLUVIUM:** A general term for all deposits resulting directly or indirectly from the sediment transport of streams, thus including the sediments laid down in riverbeds, floodplains, lakes, fans and estuaries. **ALLUVIAL** *adj.*

**ANADROMOUS:** Fish that leave freshwater and migrate to the ocean to mature then return to freshwater to spawn. Salmon, steelhead and shad are examples.

**ANTHROPOGENIC:** Caused by humans.

**ARCINFO:** ESRI (Environmental Systems Research Institute) proprietary software, which provides a complete GIS data creation, update, query, mapping, and analysis system.

**AERIAL:** Having to do with or done by aircraft. Aerial photographs are taken from aircraft equipped with cameras.

**ATHAPASKAN:** A group of related North American Indian languages including the Apachean languages, languages of Alaska, northwest Canada, and coastal Oregon and California. The Athabaskan languages formerly spoken in the northern third of Mendocino and the southern half of Humboldt counties in northwestern California fall into three broad groups of closely related dialects: Hupa-Chilula, Mattole-Bear River, and Eel River (including Cahto and the "Kuneste" (from koneest'ee', person) dialects: "Lassik", Nongatl, Sinkyone, Wailaki).

**BANKFULL DISCHARGE:** The discharge corresponding to the stage at which the floodplain of a particular stream reach begins to be flooded. The point at which bank overflow begins.

**BANKFULL WIDTH:** The width of the channel at the point at which overbank flooding begins.

**BASIN:** see watershed.

**BED SUBSTRATE:** The materials composing the bottom of a stream.

**BENTHIC:** The collection of organisms living on or in sea, river or lake bottoms.

**BOULDER:** Stream substrate particle larger than 10 inches (256 millimeters) in diameter.

**CALWATER:** A set of standardized watershed boundaries for California nested into larger previously standardized watersheds and meeting standardized delineation criteria.

**CANOPY:** The overhead branches and leaves of stream-side vegetation.

**CANOPY COVER:** The vegetation that projects over the stream.

**CANOPY DENSITY:** The percentage of the stream covered by the canopy of plants, sometimes expressed by species.

**CENTROID:** The center of water mass of a flowing stream at any location. This location usually correlates well with the thalweg, or deepest portion of the stream. Sampling in the centroid is intended to provide a reasonably representative sample of the main stream.

**CHANNEL:** A natural or artificial waterway of perceptible extent that periodically or continuously contains moving water. It has a definite bed and banks, which serve to confine the water.

**COAST RANGE:** A string of mountain ranges along the Pacific Coast of North America from Southeastern Alaska to lower California.

**COBBLE:** Stream substrate particles between 2.5 and 10 inches (64 and 256 millimeters) in diameter.

**COLLUVIUM:** A general term for loose deposits of soil and rock moved by gravity; e.g. talus.

**CONIFEROUS:** Any of various mostly needle-leaved or scale-leaved, chiefly evergreen, cone-bearing gymnospermous trees or shrubs such as pines, spruces, and firs.

**CONSUMPTIVE USE OF WATER:** Occurs when water is taken from a stream and not returned.

**COVER:** Anything that provides protection from predators or ameliorates adverse conditions of streamflow and/or seasonal changes in metabolic costs. May be Instream cover, turbulence, and/or overhead cover, and may be for the purpose of escape, feeding, hiding, or resting.

**DEBRIS:** Material scattered about or accumulated by either natural processes or human influences.

**DEBRIS JAM:** Log jam. Accumulation of logs and other organic debris.

**DEBRIS LOADING:** The quantity of debris located within a specific reach of stream channel, due to natural processes or human activities.

**DECIDUOUS:** A plant (usually a tree or shrub) that sheds its leaves at the end of the growing season.

**DEGRADATION:** The geologic process by which stream beds and floodplains are lowered in elevation by the removal of material. It is the opposite of aggradation.

**DEPOSITION:** The settlement or accumulation of material out of the water column and onto the streambed. Occurs when the energy of flowing water is unable to support the load of suspended sediment.

**DEPTH:** The vertical distance from the water surface to the streambed.

**DISCHARGE:** Volume of water flowing in a given stream at a given place and within a given period of time, usually expressed as cubic meters per second (m<sup>3</sup>/sec), or cubic feet per second (cfs).

**DISSOLVED OXYGEN (DO):** The concentration of oxygen dissolved in water, expressed in mg/l or as percent saturation, where saturation is the maximum amount of oxygen that can theoretically be dissolved in water at a given altitude and temperature.

**DIVERSION:** A temporal removal of surface flow from the channel.

**ECOTONE:** A transition area between two distinct habitats that contains species from each area, as well as organisms unique to it.

**EMBEDDEDNESS:** The degree that larger particles (boulders, rubble, or gravel) are surrounded or covered by fine sediment. Usually measured in classes according to percentage of coverage of larger particles by fine sediments.

**ECOLOGICAL MANAGEMENT DECISION SUPPORT (EMDS):** An application framework for knowledge-based decision support of ecological landscape analysis at any geographic scale.

**EMBRYO:** An organism in its early stages of development, especially before it has reached a distinctively recognizable form.

**ENDANGERED SPECIES:** Any species which is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of this Act would present an overwhelming and overriding risk to man.

**EROSION:** The group of natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the earth's surface.

**EROSIONAL** *adj.*

**ESTUARY:** A water passage where the tide meets a river current.

**EXTIRPATION:** To destroy totally; exterminate.

**EXTINCTION:** The death of an entire species.

**FILL:** a) The localized deposition of material eroded and transported from other areas, resulting in a change in the bed elevation. This is the opposite of scour; b) The deliberate placement of (generally) inorganic materials in a stream, usually along the bank.

**FINE SEDIMENT:** The fine-grained particles in stream banks and substrate. Those are defined by diameter, varying downward from 0.24 inch (6 millimeters).

**FISH HABITAT:** The aquatic environment and the immediately surrounding terrestrial environment that, combined, afford the necessary biological and physical support systems required by fish species during various life history stages.

**FLATWATERS:** In relation to a stream, low velocity pool habitat.

**FLOOD:** Any flow that exceeds the bankfull capacity of a stream or channel and flows out of the floodplain; greater than bankfull discharge.

**FLOODPLAIN:** The area bordering a stream over which water spreads when the stream overflows its banks at flood stages.

**FLOW:** a) The movement of a stream of water and/or other mobile substances from place to place; b) The movement of water, and the moving water itself; c) The volume of water passing a given point per unit of time. Discharge.

**FLUVIAL:** Relating to or produced by a river or the action of a river. Situated in or near a river or stream.

**FRESHETS:** A sudden rise or overflowing of a small stream as a result of heavy rains or rapidly melting snow.

**FRY:** Small fish, especially young, recently hatched fish.

**GEOGRAPHIC INFORMATION SYSTEM (GIS):** A computer system for capturing, storing, checking, integrating, manipulating, analysing and displaying data related to positions on the Earth's surface. Typically, a GIS is used for handling maps of one kind or another. These might be represented as several different layers where each layer holds data about a particular kind of feature (e.g. roads). Each feature is linked to a position on the graphical image of a map.

**GEOMORPHOLOGY:** The study of surface forms on the earth and the processes by which these develop.

**GRADIENT:** The slope of a streambed or hillside. For streams, gradient is quantified as the vertical distance of descent over the horizontal distance the stream travels.

**GRAVEL:** Substrate particle size between 0.08 and 2.5 inches (2 and 64 millimeters) in diameter.

**GRILSE:** see jack.

**GULLY:** A deep ditch or channel cut in the earth by running water after a prolonged downpour.

**HABITAT:** The place where a population lives and its surroundings, both living and nonliving; includes the provision of life requirements such as food and shelter.

**HABITAT CONSERVATION PLAN:** A document that describes how an agency or landowner will manage their activities to reduce effects on vulnerable species. An HCP discusses the applicant's proposed activities and describes the steps that will be taken to avoid, minimize, or mitigate the "take" of species that are covered by the plan.

**HABITAT TYPE:** A land or aquatic unit, consisting of an aggregation of habitats having equivalent structure, function, and responses to disturbance.

**HATCH BOX:** An apparatus in which environmental conditions, such as temperature and sediment, can be controlled, used for hatching eggs artificially.

**HIERARCHY:** A series of ordered groupings of people or things within a system.

**HYDROGRAPH:** A graph showing, for a given point on a stream, the discharge, stage, velocity, or other property of water with respect to time.

**HYDROLOGY:** The science of water, its properties, phenomena, and distribution over the earth's surface.

**HYDROGRAPHIC UNIT:** A watershed designation at the level below Hydrologic Region and above Hydrologic Sub-Area.

**HYPOTHESIS:** A tentative explanation for an observation, phenomenon, or scientific problem that can be tested by further investigation.

**INCUBATION:** Maintaining something at the most favorable temperature for its development.

**INSTREAM COVER:** Areas of shelter in a stream channel that provide aquatic organisms protection from predators or competitors and/or a place in which to rest and conserve energy due to a reduction in the force of the current.

**INTERMITTENT STREAM:** A stream in contact with the ground water table that flows only at certain times of the year when the ground water table is high and/or when it receives water from springs or from some surface source such as melting snow in mountainous areas. It ceases to flow above the streambed when losses from evaporation or seepage exceed the available stream flow. Seasonal.

**JACK:** An immature male salmonid (usually two-year old) that returns to freshwater to spawn. Also known as grilse.

**KNOWLEDGE BASE:** An organized body of knowledge that provides a formal logical specification for the interpretation of information.

**LAGOON:** A shallow body of water, especially one separated from a sea by sandbars or coral reefs.

**LIMITING FACTOR:** Environmental factor that limits the growth or activities of an organism or that restricts the size of a population or its geographical range.

**LARGE WOODY DEBRIS (LWD):** A large piece of relatively stable woody material having a diameter greater than 12 inches (30centimeters) and a length greater than 6 feet (2 meters) that intrudes into the stream channel. Large organic debris.

**MACROINVERTEBRATE:** An invertebrate animal (animal without a backbone) large enough to be seen without magnification.

**MAINSTEM:** The principal, largest, or dominating stream or channel of any given area or drainage system.

**MELANGE:** A mappable body of rock that includes fragments and blocks of all sizes, both exotic and native, embedded in a fragmented and generally sheared matrix.

**MIGRATION:** The periodic passage from one region to another for feeding or breeding.

**NETWEAVER:** A knowledge-based development system. A meta database that provides a specification for interpreting information.

**NUTRIENT:** A nourishing substance; food. The term *nutrient* is loosely used to describe a compound that is necessary for metabolism.

**ONCORHYNCHUS:** A genus of the family salmonidae (salmons and trouts). They are named for their hooked (onco) nose (rhynchus).

**ORGANIC DEBRIS:** Debris consisting of plant or animal material.

**ORTHOPHOTOQUADS:** A combined aerial photo and planimetric quad map (with no indication of contour) without image displacements and distortions.

**PERMANENT STREAM:** A stream that flows continuously throughout the year. Perennial.

**pH:** A measure of the hydrogen ion activity in a solution, expressed as the negative  $\log_{10}$  of hydrogen ion concentration on a scale of 0 (highly acidic) to 14 (highly basic) with a pH of 7 being neutral.

**PLATE TETONICS:** A theory in which the earth's crust is divided into mobile plates which are in constant motion causing earthquake faults, volcanic eruptions, and uplift of mountain ranges.

**PHOTOGRAMMETRY:** The process of making maps or scale drawings from photographs, especially aerial photographs.

**PRODUCTIVITY:** a) Rate of new tissue formation or energy utilization by one or more organisms; b) Capacity or ability of an environmental unit to produce organic material; c) The ability of a population to recruit new members by reproduction.

**REDD:** A spawning nest made by a fish, especially a salmon or trout.

**REFERENCE CONDITIONS:** Minimally impaired conditions that provide an estimate of natural variability in biological condition and habitat quality.

**RIFFLE:** A shallow area extending across a streambed, over which water rushes quickly and is broken into waves by obstructions under the water.

**RILL:** An erosion channel that typically forms where rainfall and surface runoff is concentrated on slopes. If the channel is larger than one square foot in size, it is called a gully.

**RIPARIAN:** Pertaining to anything connected with or immediately adjacent to the banks of a stream or other body of water.

**RIPARIAN AREA:** The area between a stream or other body of water and the adjacent upland identified by soil characteristics and distinctive vegetation. It includes wetlands and those portions of floodplains and valley bottoms that support riparian vegetation.

**RIPARIAN VEGETATION:** Vegetation growing on or near the banks of a stream or other body of water on soils that exhibit some wetness characteristics during some portion of the growing season.

**RUBBLE:** Stream substrate particles between 2.5 and 10 inches (64 and 256 millimeters) in diameter.

**SALMONID:** Fish of the family Salmonidae, including salmon, trout, chars, whitefish, ciscoes, and graylings.

**SCOUR:** The localized removal of material from the stream bed by flowing water. This is the opposite of fill.

**SEDIMENT:** Fragmented material that originates from weathering of rocks and decomposition of organic material that is transported by, suspended in, and eventually deposited by water or air, or is accumulated in beds by other natural phenomena.

**SERIAL STAGES:** The series of relatively transitory plant communities that develop during ecological succession from bare ground to the climax stage.

**SHEAR:** A deformation resulting from stresses that cause contiguous parts of a body to slide relatively to each other in a direction parallel to their plane of contact.

**SHEAR STRAIN:** A measure of the amount by which parallel lines have been sheared past one another by deformation.

**SHEAR ZONE:** A tabular zone of rock that has been crushed and brecciated by many parallel fractures due to shear strain.

**SILVICULTURE:** The care and cultivation of forest trees; forestry.

**SMOLT:** Juvenile salmonid one or more years old that has undergone physiological changes to cope with a marine environment, the seaward migration stage of an anadromous salmonid.

**SMOLTIFICATION:** The physiological change adapting young anadromous salmonids for survival in saltwater.

**SPAWNING:** To produce or deposit eggs.

**STADIA RODS:** Graduated rods observed through a telescopic instrument while surveying to determine distances and elevation.

**STAGE:** The elevation of a water surface above or below an established datum or reference.

**STRATH:** a) An extensive terrace like remnant of a broad valley floor that has undergone dissection; b) A broad valley floor representing a local base level, usually covered by a veneer of alluvium.

**STREAM:** (includes creeks and rivers): A stream is a body of water that flows at least periodically or intermittently through a bed or channel having banks and supports fish or other aquatic life. This includes watercourses having a surface or subsurface flow that supports or has supported riparian vegetation.

**STREAM BANK:** The portion of the channel cross section that restricts lateral movement of water at normal water levels. The bank often has a gradient steeper than 45 degrees and exhibits a distinct break in slope from the stream bottom. An obvious change in substrate may be a reliable delineation of the bank.

**STREAM CLASSIFICATION:** Various systems of grouping or identifying streams possessing similar features according to geomorphic structure (e.g. gradient), water source (e.g.) spring creek), associated biota (e.g. trout zone) or other characteristics.

**STREAM CORRIDOR:** A stream corridor is usually defined by geomorphic formation, with the corridor occupying the continuous low profile of the valley. The corridor contains a perennial, intermittent, or ephemeral stream and adjacent vegetative fringe.

**STREAM REACH:** A section of a stream between two points.

**SUBSTRATE:** The material (silt, sand, gravel, cobble, etc.) that forms a stream or lakebed.

**SUBWATERSHED:** One of the smaller watersheds that combine to form a larger watershed.

**TAKE:** to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.



**TERRACE:** A former floodplain underlain by sediment deposited by a stream when the stream was flowing at a higher level; typically forming a relatively level bench along a valley side adjacent to a recent floodplain.

**TERRAIN:** A tract or region of the earth's surface considered as a physical feature, an ecological environment, or a site of some planned activity of man.

**TERRANE:** A term applied to a rock or group of rocks and to the area in which they crop out. The term is used in a general sense and does not imply a specific rock unit.

**THALWEG:** The line connecting the lowest or deepest points along a stream bed.

**THREATENED SPECIES:** any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

**TOPOGRAPHY:** The general configuration of a land surface, including its relief and the position of its natural and man-made features.

**TOPOLOGY:** The analytical, detailed study of minor landforms, requiring fairly large scales of mapping.

**TRIBUTARY:** A stream feeding, joining, or flowing into a larger stream. Feeder stream, side stream.

**UNDERCUT BANK:** A bank that has had its base cut away by the water action along man-made and natural overhangs in the stream.

**VELOCITY:** The time rate of motion; the distance traveled divided by the time required to travel that distance.

**WATER RIGHT:** The right to draw water from a particular source, such as a lake, irrigation canal, or stream. Often used in the plural.

**WATERSHED ASSESSMENT:** An interdisciplinary process of information collection and analysis that characterizes current watershed conditions at a course scale.

**WATERSHED:** Total land area draining to any point in a stream, as measured on a map, aerial photograph or other horizontal plane. Also called catchment area, watershed, and basin.

**WATERSHED MANAGEMENT AREA (WMA):** In the context of the North Coast Regional Water Quality Control Board's Watershed Management Initiative, this represents a grouping of smaller watersheds into a larger area for identifying and addressing water quality problems, e.g., the Humboldt WMA includes all watersheds draining to the ocean or bays north of the Eel River to and including Redwood Creek.

**WEIR:** A barrier constructed across a stream to divert fish into a trap.

**WETLAND:** An area subjected to periodic inundation, usually with soil and vegetative characteristics that separate it from adjoining non-inundated areas.

**WILDLIFE CORRIDOR:** Linear spaces that connect the various areas of an animals habitat, links between feeding, watering, resting, and breeding places.

## List of Abbreviations

<b>BLM</b>	Bureau of Land Management
<b>CalEPA</b>	California Environmental Protection Agency
<b>Caltrans</b>	California Department of Transportation
<b>CCD</b>	Census County Division
<b>CDF</b>	California Department of Forestry and Fire Protection
<b>CEQA</b>	California Environmental Quality Act
<b>CESA</b>	California Endangered Species Act
<b>CFS</b>	Cubic Feet per Second
<b>DAU</b>	Detailed Analysis Unit
<b>DFG</b>	California Department of Fish and Game
<b>DOC/DMG</b>	California Department of Conservation-Division of Mines and Geology
<b>DWR</b>	California Department of Water Resources
<b>EMDS</b>	Ecological Management Decision Support
<b>EPA</b>	Environmental Protection Agency
<b>EPIC</b>	Environmental Protection Information Center
<b>ESA</b>	Federal Endangered Species Act
<b>ESU</b>	Evolutionarily Significant Units
<b>FPA</b>	Z'Berg-Nejedly Forest Practice Act
<b>FPR</b>	California Forest Practice Rules
<b>GIS</b>	Geographic Information System
<b>HA</b>	Hydrologic Area
<b>HCP</b>	Habitat Conservation Plan
<b>HR</b>	North Coast Hydrologic Region
<b>HSA</b>	Hydrologic Sub-area
<b>HU</b>	Hydrologic Unit
<b>IFR</b>	Institute for Fisheries Resources
<b>KRIS</b>	Klamath Resource Information System
<b>KRNCA</b>	King Range National Conservation Area
<b>LFA</b>	Limiting Factor Analysis
<b>LWD</b>	Large Woody Debris
<b>MOU</b>	Memorandum of Understanding
<b>MRC</b>	Mattole Restoration Council
<b>MSG</b>	Mattole Salmon Group
<b>MTJ</b>	Mendocino Triple Junction
<b>MWAT</b>	Maximum Weekly Average Temperature
<b>NCWAP</b>	North Coast Watershed Assessment Program
<b>NEPA</b>	National Environmental Policy Act
<b>NPDES</b>	National Pollution Discharge Elimination System
<b>NMFS</b>	National Marine Fisheries Service
<b>PSA</b>	Planning Sub Area
<b>PWS</b>	Planning Watershed
<b>RM</b>	River Mile
<b>RWQCB</b>	North Coast Regional Water Quality Control Board
<b>SPWS</b>	Super Planning Watershed
<b>SRP</b>	Scientific Review Panel
<b>SWRCB</b>	California State Water Resources Control Board
<b>TMDL</b>	Total Maximum Daily Load
<b>TPZ</b>	Timber Production Zone
<b>USFS</b>	United States Forest Service
<b>USGS</b>	United States Geologic Survey
<b>WMA</b>	Watershed Management Area
<b>WQO</b>	Water Quality Objectives

## ***DFG Appendix***

### **Introduction**

The Mattole River Basin encompasses approximately 304 square miles (787 square kilometers) of the northern California Coast Range. Although a small portion of the Mattole's southern-most headwaters lies in Mendocino County, 97.43% of the basin is in Humboldt County. The Mainstem Mattole is approximately 62 miles (100 kilometers) long, and receives water from over 74 tributary streams, including approximately 545 miles (877 kilometers) of perennial stream. The Mattole River enters the Pacific Ocean about 10 miles (16 kilometers) south of Cape Mendocino.

The Mattole Basin contains mostly steep mountainous topography, though the lower section of the Mattole River is characterized by broad flats dominated by large gravel bars (Mattole Restoration Council 1989). Headwater elevations range from 1350 feet (411 meters) at Four Corners to 4087 feet (1246 meters) at Kings Peak. Located less than three miles (4.8 kilometers) from the ocean, Kings Peak is the tallest coastal mountain in California. There are three "post office" towns in the Mattole basin: Whitethorn in the headwaters region, Honeydew near the center of the basin, and Petrolia near the mouth. The resident population in the basin in 2000 was 1,132 people (US Census).

Historically, several species of native salmonid used the Mattole River and its tributaries, including fall-run Chinook salmon, Coho salmon, summer-run steelhead, and winter-run steelhead. A United States Fish and Wildlife Service (USFWS) report estimated populations of 2000 Chinook salmon, 5000 Coho salmon, and 12,000 steelhead in 1960. More recently, a spawner survey conducted in 1994-95 estimated 500 chinook and Brown et al. (1994) estimated less than 800 adult Coho salmon in the Mattole Basin.

In order to investigate conditions for native salmonids in the Mattole River Basin, the California Department of Fish and Game (DFG) has examined salmonid presence and habitat through looking at historical records and conducting field surveys. As salmonids are influenced by geology, climate, vegetation and land use patterns, a brief overview of these factors in the Mattole Basin is provided. This overview is followed by a discussion of the issues affecting fisheries resources, the methods the DFG has used to investigate these issues and the results of these investigations.

### **Basin Overview**

#### **Geology**

The Mattole watershed is situated in a geologically complex and tectonically active area, with some of the highest rates of crustal deformation, surface uplift, and seismic activity in North America (Merritts, 1996). Basement rocks, assigned to the Coastal belt and Central belt of the Franciscan Complex by Irwin (1960) are predominantly structurally-deformed marine sedimentary rocks (McLaughlin and others, 1982, 1983, 1994). The Coastal belt has been divided into three pervasively folded, sheared and otherwise tectonically-disrupted terranes; from northeast to southwest, separated by generally northwest-trending shear zones, are the Yager, Coastal, and King Range terranes (McLaughlin and others, 1997). Late Cenozoic marine and nonmarine deposits (Wildcat Group) underlie a limited area of the watershed west and northwest of Petrolia. Quaternary alluvial deposits cover the bedrock along streambeds in the lower reaches of some tributaries and mainstem Mattole River, while remnants of older surficial deposits are locally preserved on elevated fluvial terraces in some valley areas and on wave-cut terraces along the coast.

#### **Climate**

The Mattole has a Mediterranean climate characterized by cool wet winters with high runoff, and dry warm summers with greatly reduced stream flows. Most precipitation falls as rain. Along the coast, average air temperatures range from 46 to 56 degrees F. Further inland, annual air temperatures are much more varied, ranging from below freezing in winter to over 100 degrees in summer. The Mattole basin receives one of the highest annual amounts of rainfall in California. The annual basin averaged rainfall is 81 inches. Average rainfall near the coast in Petrolia is about 50 inches per year and well over 100 inches per year

falls near the center of the basin in the Honeydew area. Extreme rain events do occur, e.g. 248.4 inches fell at Bridge Creek near Thorn Junction during 1982-83 (Mattole Restoration Council 1989).

### Vegetation

#### Land Use

The Mattole Basin was occupied by Athapaskan-speaking Mattole and Sinkyone Native Americans when the first settlers from the Eastern United States arrived in the early 1850s. Little is known about these Native Americans, as they were quickly displaced by the new settlers. Disputes over hunting ground and domestic stock culminated in a massacre at Squaw Creek in early 1864. Survivors were sent to the Round Valley Reservation in the Middle Fork of the Eel River, where most succumbed to a measles epidemic in 1868 (Mattole Restoration Council 1989).

Good farming and ranching land in the upper Mattole Basin provided opportunities for new settlers, and people moved to the area. More people were drawn with a perceived oil boom in the late 1860s, but stayed as ranchers when the oil failed to materialize (Mattole Restoration Council 1989).

More recently, most of the land use in the Mattole basin is centered on timber harvest, ranching, cattle and sheep grazing, pasture and field crops, and recreation in the King Range National Conservation Area (Mattole Restoration Council 1989).

Many roads were built to gain residential and land use access throughout the basin. A study of the upslope sources of sedimentation in the Mattole Basin carried out by the Mattole Restoration Council in 1989 found that 76% of mapped erosional disturbances were related to roads.

### **Issues Affecting Fishery Resources of the Mattole River Watershed Methods**

#### Division of Subbasins

NCWAP determined early on in their efforts that a broad-brush statement about the entire Mattole River Watershed would be difficult to make due to the large amount of variability within the watershed. Therefore, the NCWAP team divided the watershed into five subbasins based on commonalities of attributes.

#### Investigation of Existing Data

When beginning a watershed assessment, it is important to investigate existing studies and reports in a watershed. Existing data will give direction to a watershed assessment by elucidating data gaps and preventing redundancy in future data collection. In addition, the process of obtaining and using this data will provide an opportunity for participation by interested parties. Lastly, previously collected data will lead to a more comprehensive watershed assessment.

In the Mattole River Assessment, the DFG personnel participated in an extensive literature review to obtain and examine previously collected information. This information was available from both private organizations and public agencies. The DFG formed working relationships with several community-based organizations that have collected information on the Mattole River Watershed. These organizations include the Mattole Restoration Council, Salmon Restoration Group, and Sanctuary Forest. Literature was photocopied from the organizations' files and brought back to the DFG headquarters to build a library of existing documents. The DFG was also able to obtain information from the Bureau of Land Management (BLM) and the DFG North Coast Watershed Improvement Center (NCWIC). The DFG coordinated with BLM to gain access to their benthic macroinvertebrate studies and obtained recent stream habitat inventory surveys and electro-fishing inventories from NCWIC. The macroinvertebrate, habitat and electro-fishing data were placed into the library of existing documents. Everything in the library of existing documents was then entered into an annotated bibliography.

All entries in the library of existing documents were scanned for pertinent information and general conclusions about historic salmonid presence and distribution, and habitat conditions were drawn. In addition, macroinvertebrate data obtained from the BLM was further analyzed to provide a general assessment of the biological condition of the stream sites that were surveyed by the BLM.

### Stream Surveys

The DFG conducted tributary habitat inventories and biological data collections in the Mattole River Watershed in order to gain a better understanding of existing salmonid habitat and populations. Forty-nine tributaries and the headwaters of the Mattole Basin were surveyed in the watershed from 1991 to 1999 for both physical habitat data and biological data. Stream habitat inventory and biological data surveys were conducted following the protocol presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al. 1998).

Two person crews trained in standardized habitat inventory methods by the DFG conducted physical habitat inventories during a period from 1991 to 1999. Crews used the Rosgen channel typing method to determine channel types and stratify the streams into reaches. Then, the habitat type and stream length were determined for all habitat units within a survey reach. In addition, approximately 10% of the habitat units within a reach were randomly selected and sampled for all physical parameters (Hopelain, 1994). Physical parameters consisted of nine stream components: flow, channel type, temperature, habitat type, embeddedness, shelter rating, substrate composition, canopy and bank composition, and vegetation (each component is discussed in detail in the Restoration Manual). All habitat types encountered for the first time were also measured for all stream components and all pool habitat types were measured for maximum depths. Streams were surveyed until the end of anadromy was determined. Crews based this judgment on either the presence of physical barriers to fish passage or a steep gradient of 8-10% in a long continuous stretch of the stream for 1000 feet or more.

The DFG fish biologists with Smith Root Model 12 backpack electro-fishing units collected information on salmonid presence and distribution in the tributaries surveyed for habitat inventories. Data were collected from 1991 to 1999. At least one pool, run and riffle combination was sampled in each reach by electro-fishing. Salmonids were identified to species and age class was estimated based on size. Non-salmonid species were also recorded but not classified by age class.

Habitat and biological data for each sampled stream was compiled into a Stream Inventory Report, which is stored at the DFG office in Fortuna, CA.

Three streams in the Mattole Basin, Oil Creek, Rattlesnake Creek and Green Ridge Creek, were sampled more intensively by the DFG for their salmonid populations from 1991 through 1999. Preliminary data from this study are summarized in the *Stream Monitoring Progress Report for Five Small Streams in Northwestern California, Lawrence, Shaw, Oil, Rattlesnake, and Green Ridge Creeks 1991 through 1995* (Hopelain et al. 1997). One of the purposes of this study was to detect any changes in the trends of juvenile salmonid relative abundance. Annual abundance of juvenile salmonids within each sample reach was determined by depletion electro-fishing over several years. Captured fish were identified to species and measured for fork length, and weighed by displacement.

In addition, the DFG identified gaps in the spatial coverage of temperature monitoring devices used by the Mattole Salmon Group and the Regional Water Quality Control Board in 2001. Thereupon, the DFG placed 14 optic stow-away temperature monitors in 12 streams in the Mattole Basin: Lower North Fork Mattole River, Conklin Creek, Boots Creek (a tributary to Conklin Creek), Mill Creek (East), Squaw Creek, Honeydew Creek, Four mile Creek, the West Fork of Four mile Creek, the South Fork of Four mile Creek, Gilham Creek (2 monitors), Grindstone Creek (two monitors), and Sholes Creek. Monitors were placed in streams between August 15 and September 8, 2001 and retrieved between October 20 and 22, 2001. Data was downloaded and set to Jan Dirkson at the Klamath Resource Information System for analysis.

### Limiting Factor Analysis

A main component of NCWAP is an analysis of stream habitat conditions to identify factors that limit production of anadromous salmonids in North Coast watersheds. The "limiting factors analysis" (LFA) provides a means to evaluate the status of a suite of key environmental factors that affect anadromous salmonid migration, spawning, and juvenile rearing. These analyses are based on comparing extant measures of habitat components such as water temperature and pool complexity to a range of target

conditions determined from empirical studies and/or peer reviewed literature. If the component's condition does not fit within the range of the target values, it may be viewed as a limiting factor. This information will be useful to identify the underlying causes of stream habitat deficiencies and help reveal if there is a linkage to watershed processes and land use activities.

The concept that fish production is limited by a single factor or by interactions between discrete factors is fundamental to stream habitat management (Meehan 1991). A limiting factor can be anything that constrains, impedes, or limits the growth and survival of a population. Environmental factors considered to limit anadromous fish production include:

- Deficient Stream flow                      •High water temperature                      •Lack of deep pools
- Lack of shade canopy                      •Excessive turbidity                      •Lack of large wood
- Excessive sediment yield                      •Lack of instream cover

#### Limiting Factor Analysis and the Ecological Management Decision Support Model (EMDS)

We used the Ecological Management Decision Support system (EMDS) (Reynolds 1999) to perform the limiting factors analysis (LFA) and facilitate an improved understanding of the complex relationships between environmental factors, human activities, and overall habitat quality for fish. The EMDS is composed of two knowledge bases 1) stream reach condition and 2) upland condition. The Department of Fish and Game built and interpreted the results from the stream reach condition knowledge base. The Department of Forestry and Fire Protection built and interpreted the results from the upland condition knowledge base. Details of the EMDS model and knowledge bases are presented in Appendix X.

The stream reach knowledge base is composed of a group of four logic networks which describe environmental factors that affect anadromous salmonid habitat conditions: 1) Water Temperature; 2) Riparian Vegetation Function; 3) Stream Flow; and 4) In Channel Conditions (Figure ). Each of these networks is composed of a suite of stream habitat attributes and corresponding reference values, which provide a basis for evaluating field observations collected during stream habitat surveys. A proposition for each habitat attribute provides a linguistic statement to test the fitness of field observations when compared to the corresponding attribute reference value (Figure X). Each attribute evaluated by the Stream Reach Condition model may be expressed separately and/or is integrated into its parent network evaluation and the overall group evaluation of the Stream Reach Condition.

These analyses are based on the comparison of key habitat components to a range of desirable conditions. These are tools that help scientists define how a complicated ecosystem, such as a watershed functions. The software allows scientists to combine data

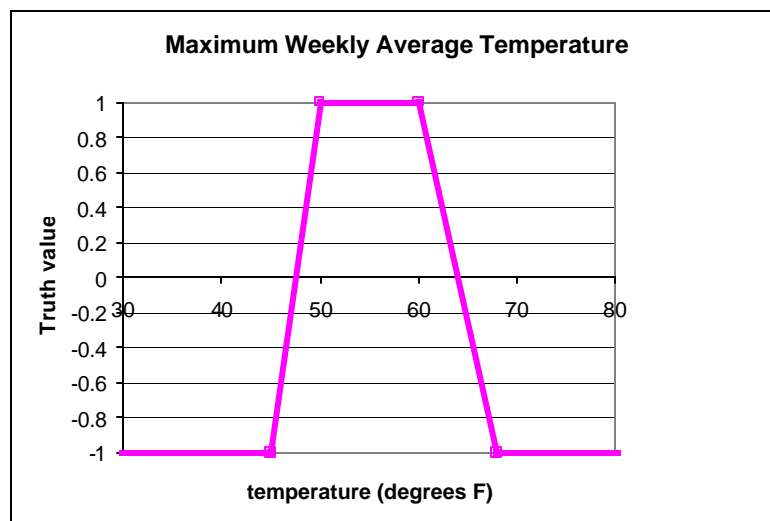


Figure X. An example of the proposition: “is the stream temperature is suitable for salmon?” The horizontal axis shows temperature in degrees Fahrenheit, while the vertical is labeled ‘Truth Value’ and ranges from -1 to +1. The line shows what are completely unsuitable temperatures (-1), completely suitable temperatures (+1) and those that are in-between ( $> -1$  and  $< +1$ ). In this way, similar graphic relations are created for all propositions in the EMDS evaluation of different environmental factors, such as stream temperature and sediment composition to produce a synthesis of watershed conditions for salmonids. The tools make possible a consistent and repeatable approach to evaluating conditions across numerous watersheds in the region. The knowledge base modeling software requires scientists to be very specific about how they believe various environmental factors interact to create conditions for anadromous salmonids in California’s north coast.

Input data for the model came directly from summaries presented in the Table 8 of Stream Habitat Inventory reports or was derived from raw field data. There were nine components to the standard habitat assessment process. Of these nine, water temperature, riparian vegetation, pool shelter complexity, and substrate composition were all directly incorporated into generating values for the EMDS model. EMDS also includes in channel conditions, pool conditions, refugia, and Large Woody Debris indices with various sub components. Descriptions of the EMDS components and how the reference values were determined are described in detail in the following section. Although some historical fish population data are available for the NCWAP assessment area, they are quite limited both spatially and temporally. Therefore, validation of the results of fish habitat studies and limiting factor analysis will depend on future population monitoring.

The results from the LFA will assist habitat management decision-making by ranking habitat factors by their influence on the overall habitat quality. The analysis also will help reveal if there is a linkage to watershed processes and land use activities. This information will be useful to identify the underlying causes of stream habitat deficiencies (limiting factors) and help focus restoration efforts and watershed management strategies to achieve the greatest salmonid production potential.

### **Review of Historical Data**

Although the declining native anadromous salmonid stocks in the Mattole Basin are often mentioned, very little quantitative historic data exist for either the basin as a whole, the mainstem Mattole River or the tributaries to the Mattole River. Stream surveys noting salmonid presence and salmonid habitat conditions were carried out by the DFG in the 1960s and estimates of Chinook salmon, Coho salmon, and steelhead populations in the Mattole Basin were made by the United States Fish and Wildlife Service (USFWS) in 1960. Existing populations of 2000 Chinook, 5000 Coho and 12,000 steelhead were estimated, while potential populations of 7900 Chinook, 10,000 Coho and 10,000 steelhead were predicted. The need for better stream survey data was recognized in 1965, when the DFG recommended that thorough surveys of existing conditions be carried out so as “to permit management of the resource by knowledge, not guesswork.”

Since that time, stream surveys of the mainstem Mattole River and the tributaries to the Mattole River have been conducted by the DFG, the BLM, the Coastal Headwaters Association, the Mattole Salmon Group, students at Humboldt State University, and other interested parties. Surveys usually examined salmonid presence, numbers (usually estimates per 100 feet of stream) and habitat (spawning gravels, nursery habitat, and shelter), but methodologies varied widely. Salmonid presence was determined through bank observation, snorkeling observations, and/or electro-fishing. Habitat characteristics were determined by direct observations; amounts of spawning gravel, nursery habitat and shelter were usually estimated but occasionally measured quantitatively. A summary of surveys conducted by the DFG and BLM from 1950 to 1990 is provided in Table X, where data has been compressed into salmonid and fish barrier presence, and spawning gravel, nursery habitat and shelter conditions. More details of tributary conditions are given in the analyses and results by subbasin.

Additional sources of information found include stocking records, watershed analyses and studies of individual tributaries. The Mattole Basin was stocked with steelhead, Coho salmon and/or Chinook salmon from 1930 to 1981 (Table X). The vast majority of fish released were steelhead. Detailed Watershed

Analyses have been carried out by the BLM for Bear Creek (1995), Honeydew Creek (1996), and Mill Creek (lower) (2001), and Hamilton (1982) surveyed Nooning Creek as part of a research proposal.

Table X. Stocking records for the Mattole Basin from 1930 to 1981.

Date	Species	Number	Where Released
1930	Steelhead	50,000	
1931	Steelhead	50,000	Upper Mattole River
1932	Steelhead	105,000	
1933	Steelhead	40,000	Upper Mattole River
1933	Steelhead	30,000	At Thorn and Ettersburg
1934	Steelhead	20,000	At Thorn and Ettersburg
1934	Steelhead	10,000	North Fork Mattole River
1934	Steelhead	10,000	
1935	Steelhead	60,000	Upper Mattole River
1935	Steelhead	36,000	North Fork Mattole River
1935	Steelhead	36,000	
1936	Steelhead	25,000	Upper Mattole River
1936	Steelhead	20,000	North Fork Mattole River
1936	Steelhead	20,000	
8/22 – 23/1938	Steelhead	2,690	Upper Mattole River
8/23/1938	Coho salmon	1,000	
8/22-24/1938	Chinook salmon	4,940	Upper Mattole River
6/20/1961	Steelhead	~59,000	Ettersburg
6/21/1961	Steelhead	~42,000	Ettersburg
6/21/1961	Steelhead	~86,000	Honeydew
5/9/1972	Steelhead	10,220	Bear Creek
5/10/1972	Steelhead	9,520	2 miles north of Whitethorn
5/12/1972	Steelhead	10,325	2 miles north of Shelter Cove
4/25/1973	Steelhead	19,067	2 miles north of Whitethorn
5/19/1975	Steelhead	30,012	2 miles north of Whitethorn
3/3-5/1981	Steelhead	100,000	Above or below Honeydew

#### **Analyses and Results by Subbasin**

Estuary

North

East

South

West









**North Coast Regional Water Quality Control Board of the State Water  
Resources Control Board (RWQCB)**

